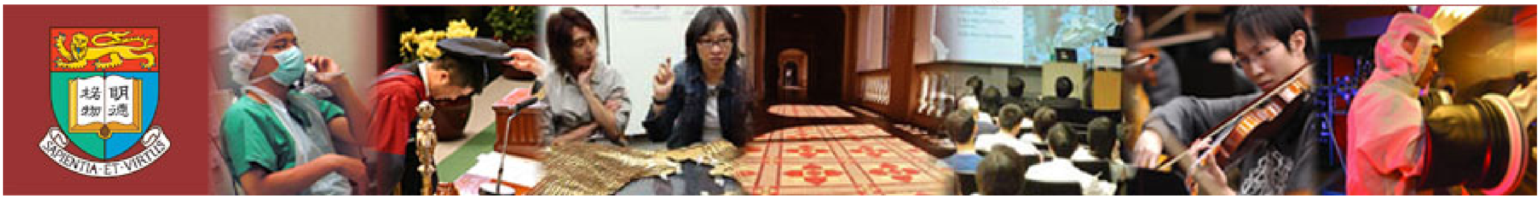

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Training comprehension of object names by behavioral intervention for children with autism using clinician or computer instruction

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Abstract

The study compared clinician and computer instruction in training object name comprehension by behavioral approach in sixteen autistic boys. Eight children were trained by a clinician, while the other eight were instructed by an animation- and sound effects-free computer program, ‘Teaching Software’. Results indicated that children in both groups learned a significant number of object names after treatment. Behavioral intervention was thus proven to be effective, regardless of the training mode. Results also revealed that the progress in the clinician and computer group did not differ significantly. Considering that previous studies showed positive effects of computer instruction when animation and sound effects were present, these findings suggested that special effects are important for the effectiveness of computer software used in the autistic population. Moreover, as individual differences were also noted, the issue of individuality must be considered when planning treatments for autistic children.

Autism, which falls under the broad heading of pervasive developmental disorders (PDD), is a spectrum of conditions characterized by impairments in communication, social relatedness and a pattern of stereotyped or repetitive behaviors of obsessive interest (Walker et al., 2004; Tager-Flusberg, Joseph, & Folstein, 2001) under the current system of the "International Classification of Diseases" (World Health Organization, 1992) and the "Diagnostic and Statistical Manual of the Mental Disorders (DSM-IV)" (American Psychiatric Association, 1994). Autism is described as one of the most severe childhood psychological disorders (Salt et al., 2001), with a prevalence of around 10 per 10,000 people in Hong Kong (Society of the welfare of the autistic persons, 2004).

Although comprehension deficit is not specifically mentioned in the diagnostic criteria of autism (Watson, Baranek, & DiLavore, 2003), children in this population are widely acknowledged to have significantly poorer receptive language ability than those of their counterparts with matched non-verbal cognitive skills (Fein et al., 1996). Comprehension difficulties not only intensify one's progress in acquiring social interaction and expressive communication, but are also frequently implicated in the development of challenging inappropriate behaviors (Watson et al., 2003). With a view to this, identifying effective comprehension intervention program is of paramount importance and treatment comparison researches are highly relevant (Bernard-Opitz, Ing & Kong, 2004).

For many years, encouraging results in adopting adult-initiated behavior intervention for ameliorating comprehension delays in many autistic children were illustrated by different researchers (Lovaas, 1981). There are multiple features that make the utilization of behavioral intervention in autistic children special (Harris & Weiss, 1998). Behavioral intervention involves intensive one-to-one clinician to child relationship in a distraction-free setting where the level of stimulation is controlled by the clinician. Complex skills are broken down and each subskill is taught via a series of massed teaching trials. Treatments are highly structured with very predictable patterns of instructions and consequences. After each appropriate response or attempt, the child is given a reinforcement. Throughout the training, the clinician keeps an objective record of the child's progress which can be used to determine when to move on within the program. The benefits of using behavioral approach in training identification of object names in children have been presented by Lovaas (2003). He stressed that through mastery of the program, children became increasingly attentive to their environment and gained improved skills in memory. Additionally, since the children could respond to some common object names, adults like parents, clinicians and teachers could increasingly manage the children on a verbal level.

Through years of investigations, the well-researched behavioral approach has been deemed as the premier choice of comprehension training in autistic children. Despite these claims of superiority, it is however acknowledged that some children were unable to benefit owing to lack of motivation, non-compliance and behavioral difficulties (Williams, Wright, Callaghan & Coughlan, 2002). The use of computers, which is becoming more popular in special education, has been suggested as a new mode for teaching autistic children in recent years. Computers are thought to be particularly appropriate to empower children with autism due to a number of theoretical reasons:

1. Children with autism often have a desire for sameness and find the world unpredictable and confusing. Consistent responses can be provided by tailor-made computer programs, in which stimuli and responses can be indefinitely, patiently and tirelessly repeated (Silver & Oakes, 2001).

2. Computer programs can generate explicit routines with consistent consequences for responding. This encourages active participation during the training (Silver & Oakes, 2001).

3. Abnormalities in sensory perception in autistic children lead to difficulties in screening out unnecessary sensory stimulation (Rutter & Schopler, 1987). Focusing on a monitor where only

crucial information is shown may minimize such problems (Moore & Calvert, 2000).

The first studies to evaluate the application of computer in autistic children begun in the 1960s and 1970s (Williams et al., 2002). One of the earliest attempts was described by Colby (1973). In Colby's computer program, pressing a letter ('H' for example) on the keyboard would generate the moving image and some interesting sound of an object (horse) beginning with that letter. He documented that 13 of the 17 recruited mute autistic children demonstrated gains in understanding of vocabulary, frequency of voluntary speech and motivation. Lately, more systematic studies were conducted and computer instruction is emerging as a prevalent method to train vocabulary knowledge for individuals with special needs, including the autistic population. Heimann, Nelson, Tjus, and Giliberg (1995) made a comparison between three groups of subjects including (1) children with autism, (2) children with cerebral palsy or learning disabilities and (3) children without disabilities. All the participants were taught to read and write single words and to create simple sentences using the program, Alpha. In Alpha, each noun or verb is immediately animated during sentence creation. Upon completion, the whole sentence is illustrated by text in conjunction with an appropriate animation or short video. All the three groups, especially the autistic group, showed significant gains in vocabulary size, word reading, phonological awareness and sentence imitation. More recently, Moore and Calvert (2000) claimed that children with autism learned more vocabulary when they were instructed by computer (74%) than by clinician (41%). In their program, reinforcements generated by on-screen animation and sound effects were extensively used to capture the children's attention and elicit their processing of information. Moreover, Bosseler and Massaro (2003) added current advances in technology to develop a three dimensional animated computer talking head, Baldi, to teach autistic children vocabulary and grammar. Using animation and sound effects, their computer tutor was proven to be effective in fostering comprehension skills in children with autism.

With the adaptation of perceptually salient animation and sound effects, these empirical prior efforts have reached a conclusion similar to Hardy, Ogden, Newman and Cooper (2002, p.1) that “children with autism like computers”. However, previous comparisons were mainly done between (1) computer instruction with animation and sound effects and (2) clinician instruction in which special effects can never present. It is difficult to evaluate whether the positive findings identified were to do with the computer as instructor, or with the application of animation and sound effects (Williams et al., 2002).

To address the issue, investigations can be done by comparing the effects of computer programs with equivalent treatment sessions conducted by clinicians. To make the two conditions ‘equivalent’, the animation and sound effects in the computer programs have to be removed and comparisons can be made between (1) sessions controlled by special effect free computer programs and (2) sessions taught by clinicians. If no significant difference is found between the two groups, this will suggest that animation and sound effects are essential ingredients of computer programs for the autistic population. However, if results show that computer instruction is more beneficial to children with autism than clinician instruction, the application of animation and sound effects may not be a major contributing factor to the success of computer tutoring and there may be other reasons for the ‘magic’ of computers.

Aim of the present study

The present study aimed at determining whether children with autism comprehend more object names if they were trained by clinician or computer software without incorporating animation and sound effects. An animation- and sound effects-free computer program, ‘Teaching Software’ was created upon the behavioral learning principles owing to its remarkable success (Lovaas, 1981). Only sounds and actions that can be demonstrated by clinicians, like clapping hands, were included so that the computer and clinician instruction conditions were comparable.

Methodology

Participants

Twenty-four young boys were recruited from the Child Speech and Language Clinic in the Division of Speech and Hearing Sciences of the University of Hong Kong and one of the local voluntary agencies, Heep Hong Society for Handicapped Children. Inclusion criteria were: (1) diagnosis of autism or autistic features by a licensed medical officer or clinical psychologist (2) chronological age of 2;00 to 5;06, (3) language age of 1;00 to 2;00, (3) absence of sensory and motor impairments, (4) good general health condition and (5) living in Cantonese speaking family. All children's parents were asked to sign a consent form (see Appendix A) before the start of the investigation.

All the enrolled participants were assessed on their play skills by Symbolic Play Test (Lowe & Costello, 1988) and their level of autistic symptomatology was rated using the Childhood Autism Rating Scale (CARS) (Schopler, Reichler & Renner, 1988). The chronological age, results of Symbolic Play Test and CARS of all the twenty-four participants were described in the first four columns in Table 1.

Material

In the current study, sixty common objects that children in Hong Kong have frequent contact with were chosen as stimuli (refer to appendix B). They were selected from local books for children and different local language assessment tools, including Cantonese Receptive Vocabulary Test (Lee, Lee & Cheung, 1996) and Cantonese Segmental Phonology Test (So, 1993).

Real objects or miniature toys were employed to represent the 60 selected stimuli and these materials were used in the clinician condition. In the computer condition, a program 'Teaching Software' was written using Flash and Action Script, which was to be run on Windows XP based personal computers (IBM ThinkPad R52). Colored photographs of the 60

Table 1

Details of all the participants

Name of subject	Age	Symbolic play score	CARS result	Initial assessment (clinician mode)	Initial assessment (computer mode)	Treatment Group
S1*	2;08	9	40	0	27	N/A
S2*	4;01	14	35	47	53	N/A
S3*	2;10	21	36	55	60	N/A
S4	3;11	14	31.5	5	0	clinician
S5	3;03	0	46	4	0	computer
S6*	3;07	16	33	51	37	N/A
S7	3;00	16	42	3	0	clinician
S8	2;06	8	41.5	0	0	clinician
S9	3;04	1	34.5	6	6	clinician
S10	2;10	3	42.5	5	6	clinician
S11	3;02	12	39	3	2	computer
S12*	2;08	11	38	36	45	N/A
S13*	2;00	0	46	0	0	N/A
S14	2;09	9	42.5	2	2	clinician
S15	3;05	11	36.5	3	4	computer
S16	2;05	10	39.5	0	0	clinician
S17*	3;00	3	45	Not done	44	N/A
S18	3;08	13	33	4	7	computer
S19	5;02	4	39.5	4	10	clinician
S20*	4;10	10	40	49	29	N/A
S21	4;11	5	40.5	2	3	computer
S22	4;05	8	34.5	1	0	computer
S23	3;09	2	42	0	0	computer
S24	2;03	9	46	4	0	computer

Note. Subjects with a * next to his name were excluded due to too advanced comprehension ability or behavioural problems.

stimuli were installed and their corresponding names were recorded using one of the clinicians' voice. The program consists of two main functions: assessment and treatment. To respond to the program, children are required to touch the designated photograph on the touch screen (N55DV TFT active matrix 15" LCD screen).

Procedure

The study was conducted in the distraction-free therapy rooms of the Child Speech and Language Clinic in the Prince Philip Dental Hospital in the Division of Speech and Hearing Sciences in the University of Hong Kong. There were individual assessments and treatments carried out either by clinician or computer. For the computer controlled assessment and treatment sessions, a clinician was assigned inside the therapy room to ensure everything was smoothly done and to give primary reinforcement (e.g. snack) if necessary. All the sessions were video-taped and implemented by four well-trained fourth year student clinicians, under the supervision of an experienced teaching consultant, Dr Diana Ho Wai Lam. In the assessments and treatments, each clinician was responsible for equal number of children from each condition. To minimize experimenter effect, children did not receive treatment and assessment from the same clinician.

The current study lasted for six weeks, with four phases including: (1) initial assessments, (2) treatments, (3) post-treatment assessments and (4) assessment for retention. The time table of the study was illustrated in Table 2.

Phase one: Initial assessment (week one)

In week one all the twenty-four enrolled participants were given two pre-treatment assessments on Thursday and Friday. Children's abilities to comprehend the sixty object names were examined by a clinician on one day and by the computer on another. To minimize order effect, twelve children were assessed by a clinician first while the other twelve were tested by a computer first.

Table 2

Schedule of the study

<table>
<tr><th></th><th>Monday</th><th>Tuesday</th><th>Wednesday</th><th>Thursday</th><th>Friday</th></tr>
<tr><td>Week 1</td><td></td><td></td><td></td><td colspan="2">Initial assessments</td></tr>
<tr><td>Week 2</td><td colspan="4">Treatments for block A (items 1-6) and block B (items 7-12)</td><td>Post-treatment assessment on block A (items 1-6) and block B (items 7-12)</td></tr>
<tr><td>Week 3</td><td colspan="4">Treatments for block C (items 13-18) and block D (items 19-24)</td><td>Post-treatment assessment on block C (items 13-18), block D (items 19-24) and assessment on the 12 control items</td></tr>
<tr><td>Week 4</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Week 5</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Week 6</td><td></td><td></td><td></td><td>Assessment for retention on blocks A, B, C, D and assessment on the 12 control items</td><td></td></tr>
</table>

1. Clinician mode of assessment. In the assessment, the clinician presented 3 objects in a row on the table simultaneously and asked the child to point to a named object. After each trial, the three presented objects were removed and another 3 items were displayed and the procedure continued. The clinician only repeated the question once if the child failed to attend to it. Items were recorded as ‘unknown’ if the child identified them wrongly or did not give any response within 10 seconds. After testing all the selected items once, correctly identified item(s) was/were tested again. An item was regarded as 'known' if the child could recognize it in three consecutive trials.

Presentation of the stimuli followed a random sequence such that the children could not anticipate which stimuli would appear next and thus to reduce false-positive errors (Lovaas, 1981). Upon showing an appropriate response, general reinforcement (such as verbal praise of the children's attentiveness or some tangible reinforcement like snack) was given so as to maintain the children's attention. Feedback of the children's response was not provided.

Before the assessment, ten minutes were spent to familiarize every child with the response mode. The clinician used verbal instructions, modeling or physical manipulation to guide the child to point to the desired object using three familiarizing items (ball, biscuit, cup). These results were not counted in the study.

2. Computer mode of assessment. In the computer mode of assessment, results were recorded by the computer. The assessment employed the same method as in the clinician mode, but was controlled by 'Teaching Software' using photographs as stimuli (See Figure 1).

In each trial, 'Teaching Software' presented three photos in a row. Name of one of the stimuli was asked and the child was required to touch the desired picture on the screen. Another three photos would then be displayed. A 'repeat once' button was built and shown in the bottom right corner of the monitor. Clinician could click it if the child failed to attend to the question at the first time.

Figure 1. A view of the assessment function of 'Teaching Software'

Verbal praise of the children's attentiveness was delivered by the program while primary reinforcement, like snack, was given by the clinician. Similar to the clinician mode, ten minutes were allocated for each child to learn to give response to 'Teaching Software' by touching the desired photograph on the touch screen.

Results of pre-treatment assessments. The initial assessments aimed at recording 'known' and 'unknown' items for every child in each of the testing mode. After gathering the results, items that were 'unknown' to a child in both modes were identified as the 'possible training items'. Participants were selected for treatments if they had at least 36 'possible training items' and showed the ability to follow the simple commands 'sit down' and 'look at' given by the clinicians or parents.

The pre-treatment assessment results were summarized in the fifth and sixth columns in Table 1. Out of the 24 enrolled participants, 16 of them met eligibility criteria and were considered as candidates for the study. Six of the subjects(S) (S1, S2, S3, S6, S12, and S20) were excluded since they had less than 36 'possible training items'. S13 was screened out as he was unaware of the adult's instructions and was consistently aloof throughout the assessments. S17 was discarded since he could not complete the computer mode of initial assessment. He was very cooperative and could comprehend 44 object names when assessed by a clinician. However he exhibited extremely irritable feeling when he entered the therapy room with a computer set inside. Even though S17 did not meet the criteria to be the subjects, he was given three extra days to try the computer software as requested by his parents. After three days of exposure, abnormalities in his emotion persisted and his parents decided to withdraw from the study.

Pretreatment comparisons. The chronological age, symbolic play test results, CARS score and number of known items prior to treatment were obtained for each of the participants during the pre-treatment assessments (refer to Table 1). T test for independent groups revealed no significant difference between the two experimental groups in all the four areas despite slight difference was noted (refer to Table 3). In short, the two conditions were comparable at intake.

Table 3

Means and t values of clinician and computer group on intake variables

	CA	Play score	CARS	Initial assessment results
Clinician group (*n* = 8)	38.88	8.13	39.19	3.13
Computer group (*n* = 8)	43.25	7.50	39.68	2.00
t-value	-0.65	0.22	-0.20	1.12
p-value	0.54	0.83	0.85	0.30

Note. CA = chorological age in months; play score = score obtained from Symbolic Play Test, CARS = score of Childhood Autism Rating Scale; Initial assessment results = number of known items in initial assessment tested by the mode that the children received treatment.

Phase two: treatments (week two and week three)

Using block randomization, the sixteen candidates were assigned to either (1) clinician instruction condition or (2) computer instruction condition and were given treatments using that mode. The grouping for the candidates was shown in the far right column in Table 1. Among the ‘possible training items’ for each child, 24 and 12 of them were randomly selected as ‘training items’ and ‘control items’ respectively. The 24 training items were divided into four blocks (A, B, C, D) with 6 items in each of the block. In week two, trainings targeted at block A (items 1 to 6) and block B (items 7 to 12). During the week, two 20-minute treatment sessions, which targeted at one block each, were given daily for a 4 day period. Each item was exposed to the child 12 times in each treatment session. Between the two sessions of training, a

20-minute break was given. In week three, same procedures were done for block C (items 13-18) and block D (items 19-24). No training was provided on the 12 control items in the treatment phase.

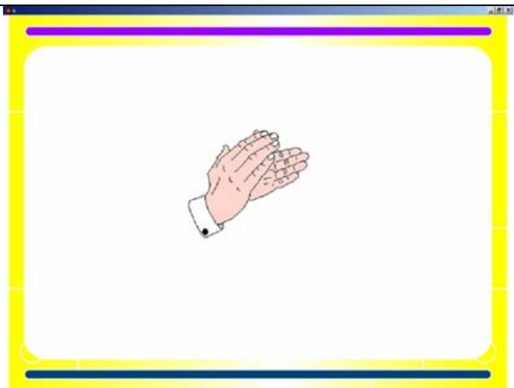
1. Clinician mode of treatment. Adopting behavioral approach, names of the training items were taught through an object labeling drill. Objects and their corresponding names were introduced to the children one by one by the clinician following a random order. After the presentation of three items, they were arranged in a row simultaneously on the table. The clinician then named one of the objects and the children were required to point to it within ten seconds.

Behavioral training also highlights the use of differential reinforcement which builds on the theory that the correct responses will be consolidated while the inappropriate one will not (Lovaas, 1981). Clear-cut reinforcement schedule was adopted in the current study. In the correct trials, verbal praise, clapping hands and tangible reinforcement like snacks were given on top of the correct feedback (the clinician repeat the object name once). If a child responded incorrectly, no reinforcement was given. The wrongly selected object was removed and modeling of the correct answer was provided as feedback. It was believed that combining the informational 'no' with the withholding of a positive reinforcer, the incorrect response can be inhibited (Lovaas, 1981).

2. Computer mode of treatment. The computer condition paralleled the object labeling drill adopted in the clinician mode, but was controlled by 'Teaching Software' using photographs as stimuli (see Figure 2). Feedback, verbal praise sounds and clapping motions were given by the program. Tangible reinforcement, like food, was given by the clinician when the children gave correct response to the computer program.

(1) During training, the photograph and the corresponding name was provided one by one. Three items were presented in the same manner.

(2) The presented three photographs were shown in a row. Name of one of the items was asked and the child was required to touch the named photo on the touch screen.



(3) In the successful trials, ‘clapping hands’ and verbal praise was given, followed by the targeted photograph and its name as feedback.

(4) In the failed trials, the wrongly selected photo was removed. The correct answer was then shown together with its name as feedback.

Figure 2. A view of the treatment function of ‘Teaching Software’

Phase three: Post-treatment assessments (week two and week three)

Post-treatment assessments were carried out on Fridays in weeks 2 and 3. Utilizing the same procedure in phase one, the following information were collected:

1. Number of known training items: In each of the assessment in weeks 2 and 3, children in both groups were tested on the two blocks taught in that week using the mode that they were trained in. Results gathered in the two post-treatment assessments were accumulated to give the ‘number of known training items’ which were used to illustrate the treatment effect.

2. Number of known generalization items: Since autistic children often fail to generalize their acquired skills to other settings (Handleman, 1979), whether children trained by computer can transfer what they have learned to an environment outside of the computer are often considered (Bosseler & Massaro, 2003). In the study, children’s generalizability of training items from the training mode to alternative testing mode was thus evaluated. In the post-treatment assessments, training items of that week were also assessed by the mode that they were not trained in. Results obtained in the 2 weeks were summated to give the ‘number of known generalization items’.

3. Number of known control items: Twelve untrained items were tested using the children’s own training mode in week 3. If there is improvement in the trained items but not the control one, the intervention can be proven to be highly efficient (Fey, 1986).

Phase four: Assessment for retention (week six)

All children received an assessment for retention twenty days following the treatment. The number of known training items, generalization items and control items were measured within one session adopting the same procedure used in phase three.

Result

The present study aimed at finding whether autistic children comprehend more object names if they were instructed by clinician or by a computer program without animation or sound effects under the same behavioral intervention procedures.

Comparisons of the mean number of known training items, number of known generalization items and number of known control items between clinician group and computer group

The null hypothesis of the current study was that children would comprehend object names in a similar rate if the interventions were instructed by clinician or computer under the same behavioral approach. T tests for independent groups revealed that children in the two conditions did not differ significantly in the mean number of known training items at post-treatment assessments (phase three) [M clin = 5.38, M com = 6.00, $t(7) = -.17$] and in the delayed recall assessment for retention (phase four) [M clin = 5.25, M com = 6.00, $t(7) = -.21$].

As can be inferred from Figure 3, there were substantial increases in the mean number of known training items in phases 3 and 4 when compared to initial assessment results while the performance of two groups were similar.

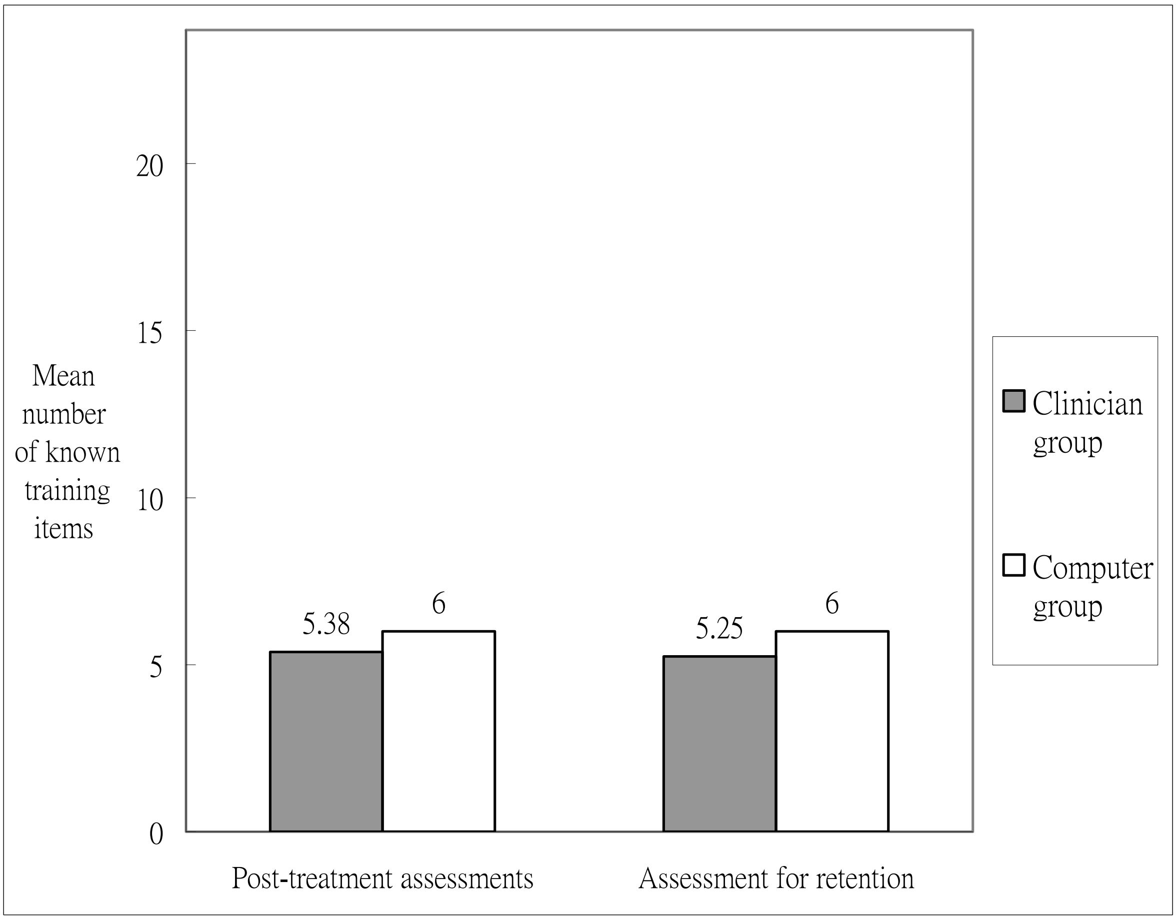


Figure 3. Comparison of the treatment effect between clinician group and computer group

T test also revealed that the two groups did not differ significantly in the mean number of known generalization items and control items collected in both the post-treatment assessments and assessment for retention. These findings were summarized in Table 4.

Table 4

Comparison of the mean number of known generalization items and control items between clinician and computer group during (1) post-treatment assessments (phase 3) and (2) assessment for retention (phase 4)

	Post-treatment assessments		Assessment for retention	
	Gen	Con	Gen	Con
Clinician group (*n* = 8)	3.25	0.88	3.25	0.63

Computer group (n = 8)	6.63	0.25	6.00	0.50
t-value	-1.38	1.49	-1.02	0.22
p-value	0.21	0.18	0.34	0.84

Note. Gen = mean number of known generalization items;

Con = mean number of known control items.

Treatment effects on clinician group

In the post-treatment assessments, large individual difference was noted in the children trained by clinician instruction. The number of known training items collected ranged from 0 to 18 with a standard deviation of 6.30. Sign test revealed clear significant gains ($p < .05$) in the mean number of known training items ($M = 5.38$) and generalization items ($M = 3.25$) when compared to the initial assessment results. No significant improvement was demonstrated in the control items ($M = .88$) when compared to the initial assessment.

In the assessment for retention, children could comprehend significantly ($p < .05$) more training items ($M = 5.25$) than the initial assessment. However, no significant gain was noted in generalization items ($M = 3.25$) and control items ($M = .63$) when compared to the initial assessment results.

Treatment effects on computer group

Similar to the results obtained from the clinician group, large individual difference was observed in the number of known training items within the computer group. The number of known training items ranged from 1 to 22 with a standard deviation of 6.97. Sign test provided support that children in this group in average could comprehend significantly ($p < .05$) more training items ($M = 6.00$) and generalization items ($M = 6.63$) in the post-treatment assessments than the initial assessment. However, no significant gain in the control items ($M = .25$) was demonstrated.

From the results collected at the assessment for retention in phase four, sign test showed that children could comprehend significantly ($p < .05$) more training items ($M = 6.00$) than pre-treatment assessment. No significant gains were seen in the generalization items ($M = 6.00$) and control items ($M = .50$).

Relationships between number of known training items after treatment with (1) age, (2) symbolic play test score, (3) CARS and (4) number of known items in initial assessments

To evaluate whether different abilities of an individual would be related to their progress in the comprehension of object names, Pearson's product-moment correlation was carried out. No significant correlations were noted between the number of known training items after treatment with (1) chronological age ($r = .11$), (2) symbolic play test score ($r = -.09$) or (3) CARS score ($r = -.13$). Only the number of known items before treatment was found to have significant correlations ($p < .05$) with the number of known training items after treatment ($r = .62$).

Inter and Intra-observer reliability

Inter and intra-observer reliability were scored on 10% of the video tapes (randomly selected) using the data collected in all the phases of the study. Pearson's product-moment correlations revealed high inter-judge reliability of $r = .97$ and an intra-judge reliability of $r = .98$.

Discussion

The purpose of the current study was to compare the effectiveness of clinician versus computer instruction using a program without animations or sound effects on training object names comprehension by autistic children.

Comparison between clinician and computer instruction without animation and sound effects

In the present study, two groups of autistic children were taught on comprehension of object names adopting the same behavioral intervention instructed by either clinician or computer software. When 24 new object names were introduced to the two groups over an 8-day period, children in both groups exhibited very similar performance. Referring to Figure 3, Children trained by clinician and computer could comprehend on average 5.38 and 6 new words, respectively, after the treatment.

The results of the present study did not demonstrate that children have a preference for computers. This finding contrasts with most of the conclusions in the literature (see, for example, Heimann and colleagues, 1995; Moore and Calvert, 2000; Bosseler and Massaro, 2003). Instructional software developed in many of these previous studies made use of special animation and sound features while ‘Teaching Software’ used in the present study did not. The difference in the software design could explain the difference in the results. This view is consistent with Huntinger (1996) who studied conditions necessary to elicit positive technology outcomes in children with special needs. He stressed that computer software is most successful when “it offers complex and interactive multimedia approaches” (Huntinger, 1996, p. 109), namely “real-time video, speech, music, silly and appealing sounds, text and high-quality graphics including captivating animation and immediate image changes” (Huntinger, 1996, p. 109). These humorous surprises often produce excited responses in children with disabilities. This finding further strengthened the necessity of using complex and interactive multimedia approaches when designing software for autistic children.

Generalization ability of Autistic children

When comparing the results across groups, children trained under both conditions did not differ significantly in the mean number of known generalization items immediately after treatment and during the assessment for retention (refer to Table 4). This suggested that the generalization ability of the two groups was similar.

Referring to the paragraph under ‘treatment effects on clinician group’ and ‘treatment effects on computer group’ in the result section, children in both groups showed generalization in immediate post-treatment assessments but not in assessment for retention. These results were surprising as autistic children are often weak in generalizing their learned behaviors (Handleman, 1979) and we did not expect that they could generalize their learnt vocabulary to an alternative testing mode in post-treatment assessments. Moreover, the discrepancies between their generalization ability in immediate post-treatment assessments and assessment for retention in both groups were very interesting. More investigations are needed to explore whether children with autism have better generalization ability shortly after treatment but not in delayed recall assessments.

Treatment effects of behavioral intervention

Results stated in ‘treatment effects on clinician group’ and ‘treatment effects on computer group’ in the result section suggested that children trained by both clinician and computer in average could comprehend significant more number of training items but not the control items after 2 weeks of treatments. Fey (1986) explained that gains in treatment goal but not in control goal can eliminate the possibility that treatment effect is due to natural growth. As the treatment procedure incorporated the thoughts of the behavioral approach, the results heighten that behavioral training have striking success in outcomes (Lovaas, 1987). The findings of the present study supported the view that behavioral management provides effective help regardless of the nature of the instruction, either carried out by clinician or computer instruction.

Evaluating the use of computers in the autistic population

In recent years, there have been mounting evidences which supported the use of computers in educating children with autism-related disabilities. In the study, most participants were subjectively judged to show enthusiasm or at least could cooperate during the sessions controlled by computers. An exception was S17, who failed to begin the assessment in the computer mode. The boy could follow the clinician’s instruction well when assessed by the clinician. He however demonstrated excessively fearful and nervous emotions when a computer set was presented to him. Fears persisted even after three days with repeated experience with the computer and it was extremely difficult to comfort the child's emotion. S17's abnormal response to a particular situation was not uncommon in the autistic population (Schopler et al., 1988). This observation was consistent with the saying that "the unique personalities and abilities of each child serve to accentuate the singularity of autism" (Simpson, 2001, p. 68). And it is this "uniqueness of autism and the myriad ways in which persons with autism spectrum disorders manifest their disability have proven to be fertile ground for the advancement of countless interventions and treatment strategies" (Simpson, 2001, p. 68).

Hardy and colleagues (2002) have devised a checklist of intentional behaviors for computer use, which is very useful for evaluating whether a child is ready to use a computer for learning. If a child shows more 'intentional behavior' (smiling in response, laughter, reaching out, changing crying tone to gain attention, simple body gesture, breathing patterns, vocalization, to and fro vocalizations, focus on objects, tracking moving object, making eye contact with person) than 'pre-intentional behavior'(sucking, crying, dribbling, rooting, facial movements, startled by a loud noise, body reflexes, tongue movement and unfocused looking around), the child is a possible candidate for computer training.

Individual variations in both groups

Large ranges and standard variations were noticed within each training group (refer to the 'treatment effects on clinician group' and 'treatment effects on computer group' in result section). The considerable differences among each group could be explained by the fact that there is no single teaching method guaranteed to work consistently with every child (Higgins & Boone, 1996). Individualization in method is always the key to appropriate instruction for autistic children (Turnbull, Turnbull, Shank & Leal, 1995).

Relationships between number of known training items after treatment with (1) age, (2) symbolic play test score, (3) CARS and (4) number of known items in initial assessments

CA, symbolic play test score and CARS results did not have significant correlation with the number of known training items after treatment. Number of known items before treatment however was proven to have a significant positive correlation with the number of known training items after treatment. This finding is consistent with Lovaas's (2003) claims that mastery of the identification of earlier objects may facilitate the learning of the new items. When conducting further research on single word comprehension, the receptive vocabulary size prior to treatment must be estimated. Since it was concluded that the more object names the child knows prior to the treatment, the more novel items they will learn after training, confounding factors may present if a study contains two groups of subjects with significant dissimilar receptive vocabulary size. In the present study, random assignment of children to the two training conditions equivalently spread the variance in children's pre-treatment score across the two groups (see Table 3), the effect of this factor was thus minimized.

Validity of the results in the present study

The study combined certain methodologies to increase the confidence in the findings.

1. Pretreatment differences between the clinician and computer group were minimized using block randomization. The assignment produced unbiased experimental groups as evidenced by minimal discrepancies in their chronological age, symbolic play test score, CARS score and number of known items before treatment (see Table 3).

2. A favorable outcome in either group could have been caused not by the experimental treatment but by the expectations of experimenters, participants or care-givers (Lovass, 1987). There were three arrangements that eliminate the possibilities of these. First, experimenters in pre-treatment and post-treatment assessments were not the same clinician who implemented intervention to the child, and they did not know which treatment group the child belonged to. In

addition, each experimenter was responsible for conducting assessment for an equal number of children from each condition. Second, the use of objective judgments could minimize the occurrences of experimenter effects. In the study, an individual was required to select a named object correctly in three consecutive trials in order to score one ‘known’ items during the assessments in all the phases. Subjective elements were implausible. All the sessions were video-taped and high inter and intra-reliability ensures the representativeness of the data. Third, the parents and participants of one group had no contact with the other group. It was unlikely that there would be placebo effects.

3. Since spontaneous recovery rate among very young autistic children is unknown (Lovaas, 1987) and maturation may contribute to improvement, control goal was used in the current study. Poor outcome in the control goals eliminated spontaneous recovery or maturation as a contributing factor to the favorable outcome in the treatment.

In short, the favorable outcome reported for each of the experimental group could be attributed to the success of behavioral treatment, despite different treatment conditions.

Limitations of the current study and recommendations for further research

The current study was limited by the small sample size and by the fact that only male subjects could be recruited. In order to increase the generalizability of the findings, further researches should expand the number of children examined and both genders could also be enrolled.

Additionally, the conclusion of the study was drawn by indirectly comparing results found in the present study with some previous researches, like Heimann and colleages (1995), Moore and Calvert (2000) and Bosseler and Massaro (2003). There were some variations in methodology when carrying out the trainings and testings, including number of vocabulary taught, duration of the programme and criteria to determine whether a child comprehend a word. When replicating the current study methodology, further research could include one more experimental group that receives trainings from computer software with animations and sound effects added. Direct comparison can then be made between the (1) clinician group, (2) computer group without animation and sound effects and (3) computer group with animation and sound effects. Since autistic children with similar levels of apparent need and attainment may require their learning to be mediated in very different ways, for example, some children are visual learners whilst others are auditory learners (Hardy et al., 2002), researches may also need to consider the type and duration of the special features being shown so as to elicit the most positive responses in the autistic children (Hutinger, 1996).

Conclusion

In sum, it was shown that autistic children did not differ significantly in learning object names comprehension when instructed by clinician or computer software without animation and sound effects when adopting the same behavioral intervention. Individual differences however were noted and the idea of individuality must always be considered when designing treatment plans for autistic children.

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Appendix A

Consent form

<u>訓練自閉症傾向兒童理解物件名稱之研究</u>

本部將進行一項研究，目的爲製訂更有效的方法訓練有自閉症傾向兒童的語言理解能力。此項研究由本部教學顧問何韋琳博士帶領研究員馬靄恩同學進行。

現誠邀閣下攜同兒子在二零零五年一月二十日至二月二十四日期間，往香港大學言語及聽覺科學部言語治療診所（地址：香港西營盤醫院道34號菲臘牙科醫院五樓）參與研究。研究內容包括兩節訓練前語言評估，然後每日一節（逢星期一至四）、共八節，每節六十分鐘的個別言語治療 (包括二十分鐘休息時間)，和四節訓練後語言評估（請參閱附頁之詳情）。於此研究後，我們會安排一次講座，讓家長了解訓練自閉症傾向兒童語言能

力的不同方法。此講座並非研究的一部份，目的是讓家長了解香港各類治療的方法，家長可自由參加。

於首次語言評估後，研究員馬靄恩同學將通過抽籤，安排閣下孩子接受傳統式語言訓練或透過電腦進行語言訓練。根據外國研究，此兩種訓練方法均有助提升自閉症兒童的語言能力，所以，我們認爲此研究的兩種訓練模式均會增進閣下孩子的語言理解能力。而閣下的支持，將有助於我們比較那一項訓練模式更加有效。我們期望各家長及孩子能完成整個訓練課程和研究計劃。根據我們的經驗，通常在訓練初期，孩子並沒有明顯的進步，在訓練的中或後期，孩子才有較明顯的進步。但是如果家長要求在訓練和研究中途退出，我們亦會接受，家長只需與負責治療的同學聯絡便可。

我們會把整個研究的訓練過程錄影及錄音，以便日後作詳細分析，所獲得的資料只會作是次研究之用，並予以保密。錄影帶及錄音帶上將不會顯示閣下孩子的姓名。

我們十分感謝閣下的的支持及參與。如有任何疑問，請致電9277 9402與馬靄恩聯絡。

同意書

本人 ____________________ *(家長/監護人姓名)* 同意 ______________ *(小孩姓名)* 參與是項研究。茲證實上述所有事項已向本人詳細解釋，本人亦完全明白一切有關安排。

本人同意____
把本人孩子的資料（出生日期、診斷、智力、語言能力、遊戲技巧能力）給予香港大學教育學院言語及聽覺科學部何韋琳博士及馬靄恩同學。

家長/監護人簽署：

____

日期：________________________________

研究員簽署：

____

日期：________________________

訓練自閉症傾向兒童理解物件名稱之研究
時間場地安排及需知事項

星期一	星期二	星期三	星期四	星期五
			2005年1月20日 首次治療前評估	1月21日 第二次治療前評估
1月24日 第1節治療	1月25日 第2節治療	1月26日 第3節治療	1月27日 第4節治療	1月28日 第1節訓練後評估
1月31日 第5節治療	2月1日 第6節治療	2月2日 第7節治療	2月3日 第8節治療	2月4日 第2節訓練後評估

			2月24日 第3節訓練後評估	

<u>講座詳情</u>：
日期：2005年2月26日（星期六）
時間：下午三時至四時
地點：香港大學言語及聽覺科學部言語治療診所
（地址：香港西營盤醫院道34號菲臘牙科醫院五樓）
主題：認識訓練自閉症兒童的方法

<u>惡劣天氣安排</u>：
如遇暴雨或惡劣天氣，請家長留意電台或電視台有關天氣、路面及交通情況的公布。如天文台於下午一時正仍發出紅色或黑色暴雨警告信號、三號或更高的風球，當日的訓練將會取消，訓練日期將會順延。

<u>退出安排</u>：
我們期望各家長及孩子能完成整個訓練課程和研究計劃。根據我們的經驗，通常在訓練初期，孩子並沒有明顯的進步，在訓練的中或後期，孩子才有較明顯的進步。但是如果家長要求在訓練和研究中途退出,我們亦會接受,家長只需與負責治療的同學聯絡便可。

* 如有任何疑問，請致電9277 9402與馬靄恩同學聯絡。

Appendix B

Stimuli chosen in the present study

Category	Stimuli
Animal	bird, dog, fish, horse, pig, sheep, tortoise
Clothing	clothes, slipper, socks, trousers
Drink	soft drink, milk, orange juice, water
Electrical appliances	fridge, light, telephone, television
Food	bread, cake, candy, egg, ice-cream, meat, vegetable
Fruit	apple, banana, grapes, orange, pear, pineapple, watermelon
Furniture	bed, chair, cupboard, sofa, table
Toiletry	bath, comb, tissue paper, toilet, toothbrush, toothpaste, towel
Toys	baby, lego
Utensils	bowl, fork, kettle, knife, spoon

Vehicles	bus, mass transit railway, plane, ship, taxi, van
Others	pillow, flower